Kidney Stone Center of the Pacific Summary of Operations 1986 to 1993

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In Memory of Doris Oshiro RN First Supervisor, Kidney Stone Center of the Pacific

The history and operational results in the six years since the Kidney Stone Center of the Pacific opened in 1986 are summarized and compared to the published literature, with particular attention to Hawaii's unique racial composition. We hope that the results will enable us to improve our management of stones in the future.

Background

The Kidney Stone Center of the Pacific began operations in December 1986; by the end of 1993, a total of 2,945 patients had been treated. The Kidney Stone Center of the Pacific is a cooperative venture of three entities: Kuakini Development Corporation, Queen's Health Technologies and Straub Imaging Services, all located in Honolulu.

In the mid 1980s the Dornier company of Germany developed the extracorporeal shock wave lithotriptor (ESWL).[1] This machine used shock waves generated by a large spark-plug-like device transmitted through water to fragment kidney stones, which could then be passed as sand-like particles through the ureter. The shock waves are aimed by using fluoroscopy to visualize the stone and are controlled by the patient's electrocardiogram (Fig 1).

Before this time, stones usually had to be removed by incising the patient, which required hospitalization and a long period of convalescence. Complications of surgery included bleeding, infection, and urinary leakage.

Lithotripsy represented a revolution in the treatment of stones; now patients could be treated as outpatients and the risk of complications was greatly reduced. Urologists in Hawaii saw the benefits of the machine and discussed how to obtain one to serve the Pacific. However, several obstacles had to be overcome.

The cost of the machine was $1.5 million, not including the space and support equipment, which brought the total cost to about $3 million. At one point a partnership of urologists was considered that would purchase, set up, and operate the machine, but that was rejected as being impracticable. Instead, interested hospitals were invited to participate. All of the hospitals on Oahu were asked to participate; finally, three hospitals contributed equal amounts of capital and combined their expertise to form the Kidney Stone Center of the Pacific. Each partner contributed support; for example, Kuakini was responsible for marketing, Queen's for scheduling and operations, and Straub for the business plan.

The location of the lithotriptor was the subject of much discussion. At first, a neutral site was considered; however, this was impracticable because ancillary services such as cystoscopy, x-ray, and post-anesthetic recovery were required. This meant a hospital site was needed, and Queen's was selected.

Meanwhile, a state review process by the State Health & Pharmacy Development Agency (SHPDA) was required. At first, there was skepticism by the board that there was a need for a machine. However, thanks to testimony by the urologists and hospitals, approval was granted and construction began.

On December 10, 1986, the first patient was treated on the Dornier HM-3. The original lithotriptor, now seven years old, continues to serve Hawaii and the Pacific today. It represents an example of the benefits of a cooperative, rather than competitive and more costly, approach to health care in Hawaii.

Review of Operations 1986 to 1993

Data Analysis

Patient records have been maintained on a personal computer using the Q & A data base since the Kidney Stone Center began operations. Standardized reporting forms permitted the collection of data in a systematic manner. The data was extracted on the computer using different criteria. Of course, the data retrieved is only as good as the data input, which is why it was important to complete the forms as thoroughly as possible.

Total Patients Treated

The total number of patients treated from December 10, 1986 to December 31, 1993 was 2,945 or about 500 patients a year (Fig 2). The total number of patients treated has remained fairly constant over the years. There was not a great monthly variation in patients treated. This information has been useful in planning for staffing and equipment allocation. Compared to national statistics, in a study of more than one million patients, Hawaii had a stone rate of 8.2 which was about average for the nation.[2]

Age of Patients

The oldest patient treated was 92 years old; the youngest, 4 years and 9 months. The average age of the patients was 43, with a mean of 40 years. Very young patients, because of their small stature, required a special arrangement of the lithotriptor gantry. Other than that, no special techniques were required for patients because of their age.

Gender

Sixty percent of the patients were male and 40% were female, which is in keeping with published statistics for stones. The literature reports that up to 70% of patients were male.[3]

Race

Hawaii has a unique mixture of races. In fact, in analyzing the data, many times determining the race of the patient was a problem because of the number of ethnic backgrounds. Of the patients treated at the Kidney Stone Center, the majority were Caucasian. It is

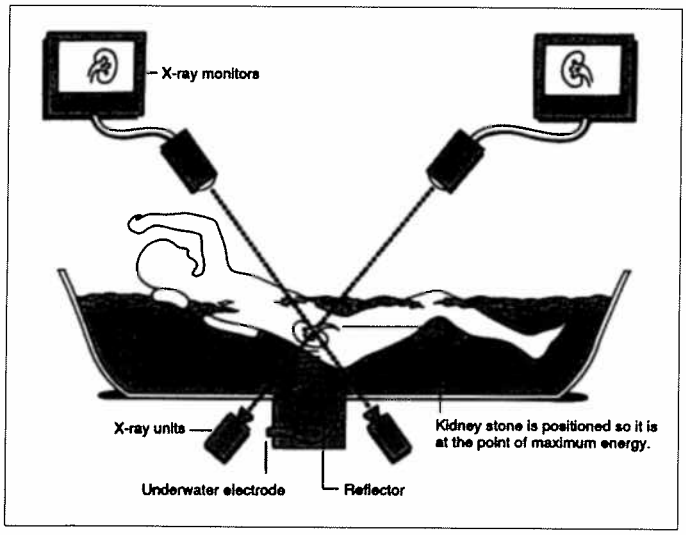

Fig 1.—Schematic of lithotriptor

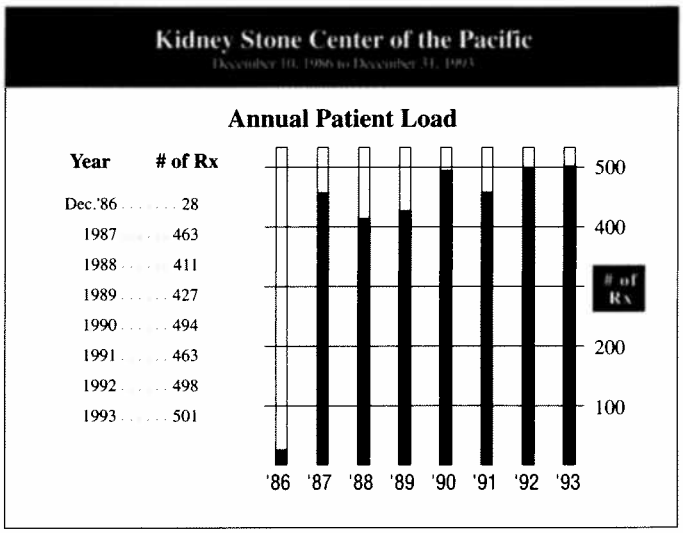

Fig 2.—Annual treatment load

interesting to compare the observed incidence of stones with the population makeup of the state (Fig 3). For example, Caucasians accounted for 34.16% of the general population in the 1990 census and represented 34.35% of the stones. Filipinos were overrepresented, comprising 15.59% of the state population, they accounted for 20.41% of the stones. The Japanese, Chinese, and Hawaiians were underrepresented.

Source of Patients

The lithotriptor serves the Pacific region including islands in the South Pacific. Non-Hawaii residents accounted for 10.6% of the treatments, including patients from the continental United States, Pacific Islands, Japan, Australia, American Samoa, Guam, and Canada.

Location of Calculi

Renal calculi accounted for 84% of the stones, with ureteral calculi representing 15.6% of the stones. Single stones were found in 69% of the patients, with multiple stones in one kidney in 21%. Single stones in both kidneys were 5% of the group, with multiple stones in both kidneys found in another 5%. Again, this is in accordance with ranges found in the published literature.[2,6]

Size of Calculi

The calculi ranged in size from <1 cm to >9 cm, and as expected, there were more smaller stones. The size of the stone is significant because the larger stone requires more shocks than the smaller one, thereby increasing the patient's exposure to shock wave energy and greater complications. In fact, some larger staghorn calculi can be treated best with percutaneous nephrostolithotomy, in which the calculi are removed through a small opening in the patient's back. As expected, the smaller stones were more prevalent.

Number of Shocks

The amount of energy varied. The mean was 21 kV with a range of 14 kV to 28 kV. The number of shocks ranged from 300 to >5000 per treatment, and the median number of shocks was 1,500 to 2,000. Generally, the larger the stone, the more shocks required. Some stones, such as uric acid stones, are harder and require more shocks. The number of shocks was less for smaller stones and increased as the stone size increased, but seemed to stabilize at about 2,500 to 2,700 shocks in the range from 4 cm to 9 cm.

Types of Stones

Stone analysis was incomplete because many of the patients had no data that could be gleaned from the records. This is expected because the data is pretreatment and, of course, stone analysis has not yet been performed. Of the 656 cases that could be evaluated, 77% had calcium oxalate, 16% uric acid, and 7% struvite. A large study indicates that the Mainland incidence of the different types of calculi are 80% calcium oxalate, 7% struvite, and only 3% each of uric acid, cystine, and calcium phosphate.[2] It is interesting to note the racial differences in relation to the type of stone (Fig 4). The only other study from Hawaii addressing this issue was published in 1970.[7] In this study, it was noted that Tripler Army Medical Center patients, who were 82% Caucasian, had only 2% uric acid calculi, while patients at St Francis Medical Center, who were 29% Caucasian, had a 29% rate of uric acid stones. When broken down, uric acid stones accounted for 30% of the stones among the Chinese, Japanese, and Filipino population. This compared to the 14% rate of uric acid stones in Caucasian patients at St Francis Medical Center. The authors noted this and suggested diet could have played a role.

Our experience more than 20 years later seems to indicate that we are seeing fewer uric acid calculi since the overall rate among the general population was 16%. However, that is still high by national standards. It is interesting to note that the Filipino and Chinese rates of uric acid stones were low, while the rate among Japanese and Hawaiian patients was significantly higher. We can only speculate about the reason for this, but diet might still be a factor.

Retreatments and Complications

Retreatments accounted for 10.7% of the cases. This is in line with the reported literature, which reports a retreatment rate of 9% to 17%.[3-6]

The rate of retreatment is particularly important because it illustrates the degree of effectiveness of treatment. We believe our figures are accurate because there is only one site for treatment with ESWL in the state.

Complications have been low, less than 1%. They have included occasional pain and nausea; however, there have been no deaths directly attributable to ESWL.

Radiation Exposure of Personnel

One of the concerns of treatment was the exposure of the staff and physicians to radiation with the use of fluoroscopy and snapshots.[8]

Radiation exposure using fluoroscopy was measured by the amount of time and number of snapshots. This ranged from <1 minute to >16 minutes, the mean was about 3 minutes. The number of snapshots taken ranged from 0 to 55 and more, which compares well with published reports from other facilities.

The radiation exposure delivered to the patient can be calculated from the fluoroscopy time and number of snapshots using measured radiation output. From the above data, the patient exposures ranged from 0.04 Gy to .21 Gy with an average of .12 Gy. This is similar to the dose delivered during other fluoroscopic procedures, such as an upper gastrointestinal barium study.

The walls and water of the stainless steel tub attenuate the scatter radiation quite effectively. This means that the radiation exposure in the vicinity of the ESWL tub is negligible, and the staff is not required to wear lead aprons during the procedure.

We have used the radiation usage and exposure for individual physicians in order to increase awareness and enable more efficient use of x-rays.

Future Studies

Our data collection has given us insight into how the Kidney Stone Center has been performing, and the retreatment rate of 10.7% falls within generally accepted standards. In the future, we will be focusing more on post-treatment outcomes. We have instituted a program of follow-up phone calls to the patients to assess their state after the treatment, focusing not only on the effects of lithotripsy, but on anesthetic effects. In this way we hope to improve patient care at the Center.

Summary

The Kidney Stone Center, now more than seven years old, has served Hawaii well. It has fulfilled its mission of serving the people in Hawaii and the Pacific Basin. During its tenure, it has provided state-of-the-art treatment and improved patient care; it has resulted in a significant net savings in patient discomfort, complications, lost work time, and hospitalization. It serves as a model for other cooperative ventures, especially in light of our limited geography and population.

Technological progress has resulted in the production of newer lithotriptors that use different means of shock-wave generation and require less anesthesia or no anesthesia at all.[9] The Kidney Stone Center is evaluating the feasibility of upgrading its lithotriptor.

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